

Science lessons and assessments - teachers' notes

In the SPRinG project we have now worked through a number of activities which were designed to help pupils work effectively in groups. We are focusing for the rest of the year on group work in Science. This document has been written to guide you through the first (of two) science topics we have selected: evaporation and condensation. It is vital that you work through the activities in this document, because the evaluation of the children's progress is tied to the activity. The activities have been carefully designed to help the children's understanding of science concepts.

What do the lessons cover?

This folder contains lesson plans designed to support the teaching of the process of evaporation and condensation through the use of collaborative group work. The lessons are relevant to science programmes of study in 'SC3 Materials and their properties' and to QCA Schemes of Work '5c Gases Around Us'; '5d Changing State' and '6d Reversible and Irreversible Changes'. Appendix 1 at the end of this pack provides science background information about the processes of evaporation and condensation. You may find it helpful to refer to this.

Have your pupils already covered the topic?

We have developed two versions of the lessons.

- **A basic version** – for pupils that have little or no understanding of the process of evaporation.
- **An extension version** – for pupils that understand the process of evaporation but have little (or even a fair) understanding of the process of condensation.

You will need to choose **ONLY ONE** of these, depending on how much experience your pupils have had with the topic.

Packs

The materials consist of the lesson plans for teachers, and group folders for each group of pupils in your class. Each group folder includes 4 individual pupil assessment booklets and 1 group-work booklet. The purpose of the individual pupil assessments is to measure the learning in progress, which takes place as a result of this group work. There will therefore be two assessments. Each pupil should complete their individual booklet at the beginning of the lesson, as these form the pre-test. They have been integrated into the lesson to act as preparation for a group discussion. It is important to collect these up so that pupils are not tempted to change their answers once the lesson has got underway! Each group will have one group-work booklet, and try to ensure that as much of this is completed as possible. We will also provide you with further individual assessment forms for the pupils to complete 2 weeks after the final evaporation lesson has finished. This is the second assessment (the post test). When groups have completed the two assessments (i.e., pre and post tests) they should be returned to us by the end of the Spring term.

Putting the lesson plans into practice.

We ask that you follow the lessons fairly closely in order to ensure that you all cover more or less equivalent material. However, you will all need to translate the plans for your own

class and our main request is that you do so in such a way that children's understanding of the process of evaporation is maximised. Use your discretion to decide whether certain activities require more or less emphasis and more or less time than set out in the plans.

There are also certain aspects of the delivery of lessons which we would ask you not to alter. A key feature of the lessons is that they include a maximum amount of pupil thinking and talking. Try to ensure that, as far as possible, time for this thinking is preserved.

In addition, the lessons have been designed to allow children to develop their own theories on the basis of their observations. Research shows that this will facilitate effective talk and thinking and so aid progress in science understanding. So while information and experiments presented in the lessons should guide children to develop a 'scientific' view, we ask you to help the children to test their own ideas rather than to give them the ideas themselves.

It is important that you read the lesson outline (basic or extension) that you plan to do at least a week before the lesson as some of the work requires some initial preparation (i.e. pupils mark the water level in a tank over a few days) prior to the first lesson.

We ask that the pupils work in groups of 4 or less and that the groups consist of pupils that were together in the SPRinG stable groups used previously.

Timetable for the Science lessons

You will see that there is a short pre-lesson activity for the pupils about a week before the first lesson. While the lessons have been written up as two sessions in each of the two versions (i.e. basic and extension), there are points where a break in the lesson is needed or where it is possible. These are marked on the session outline at the start of each session and in the lesson outline. This means that you can either break up a session to run across a number of short lessons or carry out much of a session in one long lesson. You will need a block of at least 3-4 weeks to do the lessons and related post-test. To repeat: **It is important that everyone does the pre test at the beginning of the first lesson and the post test two weeks after the final evaporation lesson. We ask that you complete the lessons and then return the two assessments for each child before the end of the Spring term.**

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1. THE MISSING WATER MYSTERY

(1 hour 10 minutes approx.)

Aim

To collect initial ideas about evaporation, form an hypothesis and develop understanding of what happens to water when it evaporates.

Resources

Group folders containing: 4 individual thinking booklets and 1 group-work booklet

Dish of water

Sheets of kitchen roll/paper towel or blackboards on which to make water handprints

Perfume or deodorant

Dish for spraying the perfume into.

Learning Objectives

- That evaporation is the process of a liquid turning into a gas and that gas flows easily from place to place.
- To explain examples of ‘drying’ in terms of factors affecting evaporation.

Lesson phases

1. Pre-lesson work (5 minutes)

✂️ _____ Lesson break necessary _____

2. Briefing – (5 minutes)

3. Class activity – The disappearing hand (5 minutes)

4. Individual thinking – What’s your theory? (10 minutes)

5. Group thinking – What’s our theory? (10 minutes)

6. Debriefing – (5 minutes approx.)

✂️Possible lesson break.....

7. Class activity – Perfume detectives (10 minutes approx.)

8. Group work – Our new improved theory? (10 minutes)

9. Debriefing – (10 minutes)

✂️Suggested lesson break.....

1. Pre-lesson work (5 minutes)

A week or so before the lesson (maybe during the period set aside for taking the register) you will need to set up a tank (or bowl) of water in the classroom.

Explain to pupils that you have received a letter from someone called Detective X.
Explain to pupils who Detective X is.

Who is Detective X?

Detective X works in a very large and very secret building called HQ. He is a very nice man but he is not a very good detective on his own. However, he always gets some clever people to help him out with investigations so he gets good results. As a result he has become quite a famous detective.

At the moment he is trying to solve the mystery of the water, which has gone missing from the school. He has some ideas but he has no proof about where the water has gone and why. He has asked whether the class can help him try to solve the mystery of the missing water.

He has sent them some questions and clues about the missing water and wants them to try and answer them. The first thing he has asked them to do is set up a tank of water and to keep a record of what happens over the next few days.

Tell pupils that Detective X has asked them to set up a tank of water and to keep a record of what happens to the water over a period of time. With the children, mark the level of the water on the tank each day or two.



Lesson break necessary

1. Briefing – (5 minutes)

At the start of the lesson, **quickly** discuss with pupils the fact that water has gone missing from the tank. Note that the water, which has gone from the tank, is not the only water missing. Water has gone missing from other places in the school (e.g. puddles in the playground, the cup of hot tea left in the staff room, from towels in some of the toilets etc.).

2. Class activity – The disappearing hand (5 minutes)

*This activity is presented in addition to the water tank as an example of evaporation – and is designed to get children thinking (although the term ‘evaporation’ should **not** be introduced yet). Instead of kitchen roll/paper towels you might like to use either individual blackboards or the class blackboard. Using the blackboard will speed the evaporation process up and pupils will see their handprints vanish before their eyes.*

Tell pupils that the first few clues about the missing water have arrived from Detective X. He has asked them to look at some handprints. Choose one person from each group to make a handprint by dipping the palm of their hand in the water, giving it a shake so it is not too wet, then pressing it onto a piece of kitchen roll/ paper towel.

If you used kitchen roll/ paper towels, hang the handprints up somewhere in the classroom. You will be returning to these hand prints in about 20 minutes – after the two activities, so that pupils can see what has happened.

3. Individual thinking – What’s your theory? (10 minutes)

Ask pupils to take out the **Individual Thinking Booklets** from their group folder and to write their full name and date on the front. These are to find out how much they already know about the missing water. Ask pupils to look at the picture of the towels on page 2 and to answer the questions about where the water has gone. Individuals note down their own theories by responding to the questions in the space provided in their booklets. Please read the questions to pupils if they have difficulties and encourage them to answer as many questions as possible but not to worry if they do not know the answers.

4. Group thinking – What’s our theory? (10 minutes)

In groups of 4, ask children to get their **Group-Work Booklet** from their folders and to write their full names and the date on the front. They should then look at **Worksheet 1: The Missing Water – What’s our theory?** and compare and discuss the individual answers they wrote down before to the same questions and also think about Detective X’s ideas. They will need to agree and write down their **best** theory about what has happened to the water and about what has made the water go.

5. Debriefing – (5 minutes approx.)

Do a very quick survey of a few groups and their different theories about the missing water. All answers should be accepted without correction as the next activities are designed to help children understand what has happened to the missing water.

The groups should now look at their disappearing handprints and observe what has happened to them. Explain that when liquids go missing it is called ‘**evaporation**’.

Ask pupils if anyone saw the water from the water tank and the towel go. So how do they know their theories were right?

Detective X has sent another clue he has found about liquids evaporating. This might give them some evidence about what has happened to the missing water.

✂.....Possible lesson break.....

6. Class activity – Perfume detectives (10 minutes approx.)

Children should be seated at their desks around the classroom.

Tell the class that perfume is a liquid like water. It has a smell mixed in with it. This test provides some clues about what happens when a liquid evaporates. You are going to pour (or spray) some liquid perfume into a dish and see what happens to it.

The children will act as smell detectives. They should put up their hands when they smell the perfume.

They will need to watch: Who smelt the perfume first?
 Who smelt the perfume last?

Also ask one or two volunteers to observe the perfume in the dish.

Invite pupils to comment on the speed with which different pupils smelt the liquid and their proximity to the perfume (i.e. those nearer smelt the perfume first). Ask children for some suggestions about why they think children around the classroom smelled the perfume at different times. You could note the various ideas on the board.

If the smell did not reach the back of the class you could ask pupils how you could help those at the back smell the perfume (e.g. wafting).

Ask the volunteers to describe what happened to the liquid perfume. Ask the class what they think happened to the perfume.

Ask what was similar and different about the evaporating hand and the evaporating perfume.

7. Group work – Group thinking (10 minutes)

Explain to pupils that they have had 2 sets of clues about evaporation (evaporating hand and perfume activities) and that these will probably have given them some ideas about what has happened to the missing water.

Ask groups to complete **Worksheet 2** on **pages 4 and 5** of their **Group-Work Booklets**. They may need to have another think about their theory of what happened to the missing water and come up with an improved theory.

8. Debriefing – (10 minutes)

Get groups to feedback their ideas about what they think happens to evaporated water.

Try to draw out children's own ideas that seem relevant, (e.g. about transformation of liquid to gas) to guide any debate over differences in ideas between groups but not simply to put forward the teacher's correct version.

✂.....**Suggested lesson break**.....

2. THE CHALLENGE: TESTING YOUR THEORY.

(1 hour 5 minutes approx.)

Aim

To state and investigate a hypothesis: developing understanding of factors which affect the rate of evaporation.

Resources

Group work booklets

Dishes for water (to simulate puddles)

Kitchen roll sheets (to simulate cloths/ towels etc)

Any other equipment which may be needed for investigations – e.g. thermometers and timers for measurements.

Learning objectives

- to explain everyday examples of ‘drying’ in terms of factors affecting evaporation
- to construct a fair test and use results to draw conclusions
- to explain conclusions in terms of scientific knowledge and understanding

Lesson phases

1. Briefing – Plan an investigation (5 minutes)
2. Group work – Planning the experiment (15 minutes)
3. Plenary (10 minutes)
4. Group work – Carrying out the test (30 minutes approx.)

✂.....Possible lesson break.....

5. Group work – Analysing the results of the experiment (10 minutes)
6. Debriefing – (10 minutes)

✂.....Possible lesson break.....

Optional

7. Follow up work – Solid, liquid and gas: particle theory (35 minutes)
 - 7a. Class activity – States of matter (5 minutes)
 - 7b. Class activity – Differences in the state of matter (10 minutes)
 - 7c. Group work – Evaporation and states of matter (10 minutes)
 - 7d. Debriefing – (10 minutes)

1. Briefing – Plan an investigation (5 minutes)

Recap over the previous lesson. Congratulate pupils on all the hard work they have put in so far. Detective X will be pleased.

Explain to pupils that now they need to collect some evidence to show what made the water go. To do this they will have to plan a test to find out whether their theory about what made the water go is right. If necessary it may be useful to spend some time talking about how to do fair tests.

2. Group work – Planning the experiment (15 minutes)

Note for teachers: *The worksheet gives some suggested equipment for the test but leaves it to the groups to decide exactly what to do. Examples of tests could be putting drops of water in hot/ cold places to explore effects of heat on evaporation; folding wet kitchen roll twice, once and not at all to explore effects of exposure of surface area; creating different degrees of ‘wind’ (e.g. by blowing) to explore effects of air movement on evaporation.*

If children have appropriate ideas about how to carry out tests they can use those. However you can give as much guidance and prompting as necessary to ensure that the test is fair and properly carried out as long as there is no interference with the children’s own hypotheses.

Use of drops of water, kitchen roll etc. is suggested as it should not take too long for evaporation to take place.

It is left up to you to decide the appropriate level of complexity of the investigation (e.g. use of thermometer or whether heat is varied only in terms of a hot, warm and cold; recording of results in tables or graphs etc.).

In their groups, pupils should use ‘**Worksheet 3 - Planning a test**’ on **pages 6-7** of their **Group-Work Booklets** to help them. The groups are directed to ask teacher for help with the test if necessary.

3. Plenary – (10 minutes)

Ask groups to quickly outline to the class what they plan to do. You could encourage questions or comments (constructive) from the rest of the class.

4. Group work – Carrying out the experiment (30 minutes approx.)

Children carry out their investigation. Teacher monitors the test to make sure plans are followed, recording is undertaken etc.

NOTE: *It may be necessary to break the lesson here to ensure that there has been time for the evaporation to take place.*

✂Possible lesson break.....

5. Group work – Analysing the results of the experiment (10 minutes)

Encourage pupils to discuss what their findings show by looking at the patterns in the data. Do they support their theory? They then should discuss and complete the questions on **Worksheet 4** on **pages 8-9** of their **Group-Work Booklets**. After this ask groups to discuss and write down their final theory about what made the water go from the puddle/ cloth/ towel in the light of evidence from their test.

6. Debriefing - (10 minutes)

Ask groups to explain briefly to the class what evidence they will be presenting to Detective X.

- First they should say what their original theory said about ‘what made the water go’,
- and then how their test supported (or failed to support) their theory

Note to teachers: *You should draw out salient points during group feedback – encourage constructive questions, comments and discussion between groups about their work.*

✂Possible lesson break.....

7. Follow up work – Solid, liquid and gas: particle theory (35 minutes)

NOTE: This work is optional. *The aim of the follow up work is to extend understanding of what happens to water when it evaporates by introducing the idea that solids, liquids and gases can be explained as particles existing in different states.*

7a. Class activity – States of matter (5 minutes)

Explain to pupils that Detective X has spoken to some Scientists who have given him some information that explains the differences between ‘**solids, liquids and gases**’.

Page 10 of their **Group-Work Booklets** are some notes that Detective X has written after his discussion with the Scientists. The notes may help them to understand even more about what happens to water during the process of evaporation.

Read through the notes with pupils asking them relevant questions where appropriate.

7b. Class activity – Differences in the state of matter – (10 minutes)

NOTE: *You will need a spacious area (class, gym or playground) to illustrate differences in the state of material (e.g. water).*

Tell pupils to pretend that they are particles of water and are going to act like water when it is a solid liquid and a gas.

1. ask pupils to crowd together and to link arms tightly and to remain still. Groups act as particles in a solid (e.g. **ice**) by crowding together, linking arms tightly and remaining still. One or two sensible children should be chosen to try and shake links apart – this should be difficult. Explain that this is what water is like when it is a solid. Point out that this is because they have little energy. With heat particles gain energy and their links with other particles get weaker and a liquid begins to form.
2. ask pupils to act as particles in a liquid (e.g. **water**) by holding hands loosely but moving around the space following a ‘lead’ particle. Point out that they are now gaining more energy. Volunteers should try and shake links apart – this should be quite easy. With heat particles gain even more energy and eventually break their links to form a gas.
3. ask pupils to act as particles in a gas (e.g. **water vapour**) by not holding hands and moving around where they want. They should move quite quickly and independently and spread out into available space. Point out that they have now got a lot of energy.

7c. Group work – Evaporation and states of matter – (10 minutes)

Ask groups to use the notes from Detective X about particles in a solid, liquid and gas **to help them explain** what happened to the perfume and water in their evaporation tests (The Disappearing Hand, The Evaporating Perfume and your group experiment of what made the water go)? They should discuss and answer the questions on **Worksheet 5** on **page 11** of their **Group-Work Booklets**.

7d. Debriefing – (10 minutes)

Hold a final plenary session to collect ideas/theories from groups about what happens to evaporated water in terms of particles – and relate this as far as possible to their ideas about changes in particles in liquid and gas and changes in energy levels of particles.

NOTE: *Try to draw out children’s own ideas that seem relevant, to guide any debate over differences in ideas between groups but not simply to put forward the teacher’s correct version.*

1. THE MISSING WATER MYSTERY

(35 minutes approx.)

Aim

To revise and consolidate ideas about evaporation

Resources

Group folders containing: 4 Individual thinking booklets and 1 group-work booklet

Learning objectives

- that evaporation is the process of a liquid turning into a gas and that gas flows easily from place to place.
- to explain examples of ‘drying’ in terms of factors affecting evaporation

Lesson phases

1. Pre-lesson work (5 minutes)

✂—————Lesson break necessary—————

2. Briefing – (5 minutes)

3. Individual thinking – What’s your theory? – (10 minutes)

4. Group thinking – What’s our theory? (10 minutes)

5. Plenary – (5 minutes)

✂.....Suggested lesson break.....

1. Pre-lesson work (5 minutes)

NOTE: *If you feel pupils have a firm understanding of evaporation then you should miss out this following pre-lesson work and move on to 2. Briefing but you will need to introduce Detective X at the start of the first lesson.*

A week or so before the lesson (maybe during the period set aside for taking the register) you will need to set up a tank (or bowl) of water in the classroom.

Explain to pupils that you have received a letter from Detective X (**explain who Detective X is** – see below). Tell pupils that he has asked them to set up a tank of water and to keep a record of what happens over the next few days. They are going to be looking at what happens to the water over a period of time. With the children, mark the level of the water on the tank each day or two.

✂—————Lesson break necessary—————

2. Briefing – (5 minutes)

Note: If you did the pre-lesson and set up a tank of water, look at the fact that water has gone missing from the tank. Otherwise, explain to pupils that you have received a letter from Detective X (**explain who Detective X is** – see below).

Who is Detective X?

Detective X works in a very large and very secret building called HQ. He is a very nice man but he is not a very good detective on his own. However, he always gets some clever people to help him out with investigations so he gets good results. As a result he has become quite a famous detective.

At the moment he is trying to solve the mystery of the water, which has gone missing from the school. He has some ideas but he has no proof about where the water has gone and why. He is also trying to get the water back. He has asked whether the class can help him try to solve the mystery of the missing water.

He has sent them some questions and clues about the missing water and wants them to try and answer them. Tell children that they are going to be detectives working on the case of the ‘missing water mystery’.

Tell pupils that Detective X has noticed that water has gone missing from a number of places. Water has gone missing from:

- puddles in the playground (but only the ones in the sun),
- a cloth which was spread out on a chair, but not from the cloth that was folded up beside it,
- the towel hung out on the washing line at Detective X’s HQ but not from the one that was left screwed up and left on the bathroom floor.

Ask pupils what the process is called when water goes missing (i.e. elicit the term ‘Evaporation’ for the reduction in the water). Don’t ask them what evaporation involves.

Tell pupils that Detective X has sent some information from HQ about this missing water and some questions which he wants them to answer.

3. Individual thinking – What’s your theory? – (10 minutes)

Ask pupils to take out the **Individual Thinking Booklets** from their group folder and to write their full name and date on the front. Ask them to look at the picture of the towel and to answer the questions about where the water has gone. Individuals note down their own theories by responding to the questions in the space provided in their booklets.

4. Group thinking – What’s our theory? (10 minutes)

In their groups of 4, ask pupils to get their **Group-Work Booklets** from their group folders and to write their full names and the date on the front. They should then look at **Worksheet 1** on **page 2** and then compare and discuss their individual answers (written in their individual booklets) to the same questions and also think about Detective X’s ideas. They will need to agree and write down their **best** theory about what has happened to the water and about what has made the water go.

5. Plenary – (5 minutes)

Do a very quick survey of a couple of groups and their different theories about the missing water. You may want to draw out theories and get groups to ask questions of each other.



.....**Suggested lesson break**.....

2. IS EVAPORATION REVERSIBLE?

(1 hour 35 minutes approx.)

Aim

To form a hypothesis and collect evidence to test the hypothesis

Resources

Group work folders

Kettle, ovenproof dish and oven glove for teacher demonstration

2 containers for warm water and water at room temperature per group

2 small mirrors per group

2 bottles of drink (transparent with coloured water if possible) per group. 1 should be cold from the fridge, the other at room temperature

Learning objectives

- that condensation is the reverse of evaporation
- that air contains water vapour and when this hits a cold surface it may condense

Lesson phases

1. **Briefing – whole class activity** (5 minutes)
2. **Group work – Can we get evaporated water back?** (15 minutes)
3. **Class activity – The kettle activity** (5 minutes)
4. **Group thinking** – (5 minutes)

✂.....Possible lesson break.....

5. **Class activity – States of matter** (5 minutes)
6. **Class activity – Differences in the state of matter** (10 minutes)
7. **Group work – Evaporation and states of matter** (10 minutes)

✂.....Possible lesson break.....

8. **Group work – The bathroom and fridge tests** (20 minutes approx.)
 9. **Group work – A new improved theory?** (10 minutes)
 10. **Debriefing** – (10 minutes)
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1. Briefing – whole class activity (5 minutes)

Recap and discuss with your class the ideas about what made the missing water evaporate as discussed in the previous lesson.

2. Group work – Can we get some evaporated water back (10 minutes)

Explain to pupils that they have provided Detective X with theories about where the missing water has gone and what made it go from the towel. Now he is sending you on a mission to find out if he can get some evaporated water back.

Tell pupils they are going to devise some theories and carry out some activities which should help them to give Detective X this information. In their groups, pupils should discuss the questions on **Worksheet 2** on **page 4** of their **Group-Work Booklets** about how we could get some of the evaporated water back. They should try to reach agreement over their answers.

3. Class activity – The kettle activity (5 minutes)

Tell pupils that the first clue from Detective X about how to get the missing water back has arrived. Detective X says they should watch what happens when a kettle is boiled.

Notes to teachers: Boil a kettle and using an oven glove hold a metal oven tray (or ovenproof dish) at an angle above the steam (be careful you don't burn yourself) that comes out from the kettle. If you can prevent the kettle from switching itself off so much the better. Alternatively bring the kettle to the boil a couple of times. You might need a dish to collect the water as it condenses on the dish and runs off. Get a pupil to describe to the class what is happening to the water vapour. Introduce the term condensation.

4. Group thinking – (5 minutes)

Ask groups to discuss and answer the questions about the kettle activity as set out on **Worksheet 3** on **page 5** of their **Group-Work Booklets**.

✂.....Possible lesson break.....

5. Class activity – States of matter (5 minutes)

Explain to pupils that Detective X has spoken to some Scientists who have given him some information that explains the differences between '**solids, liquids and gases**'. **Page 6** of their **Group-Work Booklets** are some notes that Detective X has written after his discussion with the Scientists. The notes may help them to understand even more about what happens to water during the process of evaporation.

Read through the notes with pupils asking them relevant questions where appropriate.

6. Class activity – Differences in the state of matter – (10 minutes)

NOTE: You will need a spacious area (class, gym or playground) to illustrate differences in the state of material (e.g. water).

Tell pupils to pretend that they are particles of water and are going to act like water when it is a solid liquid and a gas.

1. ask pupils to crowd together and to link arms tightly and to remain still. Groups act as particles in a solid (e.g. **ice**) by crowding together, linking arms tightly and remaining still. One or two sensible children should be chosen to try and shake links apart – this should be difficult. Explain that this is what water is like when it is a solid. Point out that this is because they have little energy. With heat, particles gain energy and their links with other particles get weaker and a liquid begins to form.
2. ask pupils to act as particles in a liquid (e.g. **water**) by holding hands loosely but moving around the space following a ‘lead’ particle. Point out that they are now gaining more energy. Volunteers should try and shake links apart – this should be quite easy. With heat particles gain even more energy and eventually break their links to form a gas.
3. ask pupils to act as particles in a gas (e.g. **water vapour**) by not holding hands and moving around where they want. They should move quite quickly and independently and spread out into available space. Point out that they have now got a lot of energy.

7. Group work – Evaporation and states of matter – (10 minutes)

Ask groups to use the notes from Detective X about particles in a solid, liquid and gas **to help them explain** what happened to the water in the kettle when it evaporated and condensed. Ask the group to discuss and answer the questions on **Worksheet 4** on **page 7** of their **Group-Work Booklets**.

✂.....Possible lesson break.....

8. Group work – The bathroom and fridge tests – (20 minutes approx.)

Notes for teachers: for the bathroom exercise you will need some water from the hot tap (but not too hot) and water that is at room temperature which you can pour into small bowls (or cups). Give each group two bowls. One half full with hot, the other half full with water at room temperature and two mirrors. Groups are to hold the mirror over each bowl of water for a minute or two (keep this constant). Vapour should appear on one mirror (the one held over the bowl containing hot water).

Notes for teachers: For the fridge test you will need to have 2 bottles per group containing coloured water. Try to use transparent bottles with coloured

water so that the condensation can be seen to be different from the liquid inside the bottle. Half of the bottles will need to have been in the fridge for a few hours (preferably over night). The other half will need to have been in the classroom for a few hours at least. Give each group one bottle containing cold water and one containing water at room temperature.

Groups then carry out the bathroom test followed by the fridge test. They should follow the instructions and answer the accompanying questions on **Worksheet 5** on **page 8-9** (bathroom test) and **Worksheet 6** on **page 10** (fridge test) of their **Group-Work Booklets**.

9. Group work – A new improved theory? (10 minutes)

Refer groups back to original notes which they made about factors which may reverse the process of evaporation (**page 4**). Groups should discuss whether they still agree with their ideas and modify them if necessary. They should answer the questions on **Worksheet 7** on **page 11** of their **Group-Work Booklets**.

10. Debriefing – (10 minutes)

Hold a plenary type session collecting ideas from groups about condensation – and relating this as far as possible to their ideas about changes in particles in liquid and gas and changes in energy levels of particles.

NOTE: *Try to draw out children's own ideas that seem relevant, to guide any debate over differences in ideas between groups but not simply to put forward the teacher's correct version.*

✂Possible lesson break.....

3: THE WINDOW TEST

(1 hour approx.)

Aim

Application of understanding - Stating and testing a hypothesis

NOTE: *It would be useful to include this activity but you may decide to omit it if your pupil's understanding of this area is good. If you do, then please use the time saved to ensure thorough coverage of the material on solid, liquids and gases.*

Resources

4 glasses of water (3 of which are to be put in a fridge)

Access to fridge

Thermometer (optional)

Learning objectives

- that air contains water vapour and when this hits a cold surface it may condense
- to explain conclusions in terms of scientific knowledge and understanding

Lesson phases

1. **Group thinking** – (10 minutes)
 2. **Class experiment** – (30 minutes approx.)
 3. **Group thinking about the experiment** – (10 minutes approx.)
 4. **Debriefing** – (10 minutes approx.)
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1. Group thinking – (10 minutes)

Explain to pupils that Detective X has come up with an idea for how to get some evaporated water back. He believes that he may be able to collect some water when it condenses on the windows at HQ. He also thinks that it will be best to do this in summer time rather than winter time. Detective X has suggested a test for us to do to find out if he is right.

To prepare for the experiment, ask a volunteer to go and put 3 glasses of water in a fridge and record the time that they do this. Keep the 4th glass of water in the classroom.

Groups discuss if they think Detective X is right and give an explanation for their response - using questions on **Worksheet 8** on **page 12** of their **Group-Work Booklets**.

2. Class experiment (30 minutes approx.)

Explain that this experiment is to test Detective X's ideas:

- That Detective X can collect some water when it condenses on windows at HQ
- That it will be best to do this in summer time rather than winter time

Explain to pupils that the glass in Detective X's windows will be simulated by drinking glasses in this experiment.

Teacher to carry out a test to demonstrate that the colder the surface, the more condensation takes place – i.e. to show that Detective X's idea is wrong.

When 10 minutes have elapsed since the volunteer put the glasses in the fridge, ask the volunteer to bring back one of the glasses. The next glass will be collected after 20 minutes and the final glass after 30 minutes have elapsed.

Get the class to observe and describe what happens to the glass and make a judgement about the amount of condensation on the outside of the glass. The temperature of the water in the glass should also be recorded and will indicate the differences in the temperature of the glasses and thus can be compared to the amount of condensation produced. Observations should also be made of the glass which has not been put in the fridge. Groups should record their results in the table on **page 13** of their **Group-Work Booklets**.

3. Group work – Analysing the results (10 minutes approx.)

Ask groups to turn to **page 14 - Worksheet 9**, to look at their record of results, and to think and discuss what the results show. They should answer the questions on the worksheet.

4. Debriefing – (10 minutes approx.)

Class survey of whether groups think they can get some of the water back for Detective X. Can evaporation be reversed and how?

NOTE: draw out salient points during group feedback – encourage discussion between groups about their work - in order to underline the meaning of condensation in terms of the reversal of evaporation. You may want to relate this back to particle theory.

APPENDIX - EVAPORATION and CONDENSATION

Background information

- Evaporation occurs when a liquid dries up. Those molecules (or particles) on the surface of the liquid, which have more energy, change to a colourless gas called water vapour. They move from the liquid into the air. The more liquid that is exposed to the air, the faster it will evaporate. Molecules in liquid are close to each other but are loosely linked, can roll around and so a liquid can change its shape. As evaporation occurs, the molecules, which gain enough energy to break their bonds, move faster and further apart to become a gas.
- Evaporation can occur at low temperatures because some molecules have enough energy to escape. Evaporation increases as the temperature rises because the surface molecules gain more energy and move away faster. If water is made hot enough, all the molecules will evaporate and the water boils away.
- As evaporation occurs it has a cooling effect on the remaining liquid.
- Cold slows down evaporation and may even stop it, turning the water vapour back into water droplets. Molecules, which have formed a gas, lose energy in the cold and move close together to become a liquid again. This process is called condensation. These water droplets may be suspended in the air (e.g. as mist, breath in cold air). If these tiny droplets hit a cold surface they coalesce further to form larger drops of water.
- Humid air contains a great deal of water vapour (and is saturated with water molecules), so water will not easily evaporate into it. Wind disperses the water vapour (and molecules), reduces humidity and so speeds up evaporation.
- Some liquids will evaporate more quickly than others at a given temperature.

Children's ideas

Children may hold various misconceptions about evaporation and condensation.

- Some simply believe that evaporated water has disappeared and that no further explanation is required.
- Children who believe that water still exists may also have misconceptions about:
 - The location of the evaporated water (e.g. the sun, soaked into the ground, soaked into the cloth/ towels)
 - Factors causing evaporation (e.g. a human agent, the sun rather than heat in general)
- They may have little understanding about the change of state of water from liquid to gas during the process of evaporation and from gas to liquid during the process of condensation.
- They may not realise that the product which results from the process of condensation is water.
- They may not realise that this water has come from the air. For example, in 'The Fridge Test' they may believe that the liquid on the outside of the cold bottle is drink which has seeped out of the bottle.